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Title of Invention : COATING FOR A STEAM GENERATING  
DEVICE

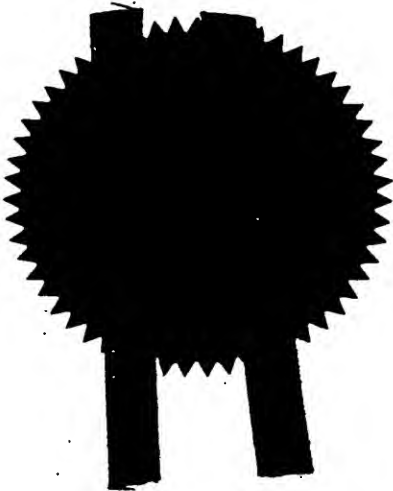


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0-1	International Application No.	PCT/SG 03 / 00105
0-2	International Filing Date	25 APR 2003 (25-04-03)
0-3	Name of receiving Office and "PCT International Application"	REGISTRY OF PATENTS (SINGAPORE) PCT INTERNATIONAL APPLICATION
0-4	Form - PCT/RO/101 PCT Request	
0-4-1	Prepared using	PCT-EASY Version 2.92 (updated 01.04.2003)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	Intellectual Property Office of Singapore (RO/SG)
0-7	Applicant's or agent's file reference	PNL030488WOP
I	Title of Invention	COATING FOR A STEAM GENERATING DEVICE
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III-1-11	Applicant's registration No. with the Office	GPA 02/0007
<b>V</b>	<b>Designation of States</b>	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE TR and any other State which is a Contracting State of the European Patent Convention and of the PCT (except BG CZ EE HU RO SI SK)
V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	SG
V-5	Precautionary Designation Statement  In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.	
V-6	Exclusion(s) from precautionary designations	NONE
VI	Priority claim	NONE
VII-1	International Searching Authority Chosen	European Patent Office (EPO) (ISA/EP)

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<b>VIII</b>	<b>Declarations</b>	<b>Number of declarations</b>	
VIII-1	Declaration as to the identity of the inventor	-	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	-	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	-	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	-	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	-	
<b>IX</b>	<b>Check list</b>	<b>number of sheets</b>	<b>electronic file(s) attached</b>
IX-1	Request (including declaration sheets)	4	-
IX-2	Description	5	-
IX-3	Claims	2	-
IX-4	Abstract	1	EZABST00.TXT
IX-5	Drawings	2	-
IX-7	TOTAL	14	
	<b>Accompanying items</b>	<b>paper document(s) attached</b>	<b>electronic file(s) attached</b>
IX-8	Fee calculation sheet	✓	-
IX-11	Copy of general power of attorney	reference no. GPA 02/0348	-
IX-17	PCT-EASY diskette	-	Diskette
IX-19	Figure of the drawings which should accompany the abstract	1	
IX-20	Language of filing of the international application	English	
X	Signature of applicant, agent or common representative		
X-1	Name (LAST, First)	Frederik J. SMT	
X-2	Capacity	(Authorized representative)	

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10-1	Date of actual receipt of the purported international application	12 5 APR 2003 (25-04-03)
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/EP

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10-6	Transmittal of search copy delayed until search fee is paid	
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## Coating for a steam generating device

Laundry irons launched in 1992 had a steam rate and a power, which was about twice as low as irons brought on the market in 2002. The higher steam rate, up to 40 grams per minute, makes the ironing process faster. This trend towards higher steam rates imposes increased demands on the control of the heat transfer between the steam chamber surface and the liquid to be evaporated. The efficiency of steam formation depends on the temperature of the surface of the steam chamber. If the temperature of the steam chamber is too high, higher than about 160°C, a vapour layer develops in-between the substrate and the water to be evaporated. This reduces the heat transfer dramatically. At a fixed, high, dosing rate liquid water may build up in the steam chamber causing leakage and in the so-called shot-of steam area the expulsion of macroscopic droplets rather than steam may occur.

As most irons have only one heating element, which is used for heating the sole-plate as well as the steam chamber surface, a too high temperature in the steam chamber easily occurs. The lowering of the heat transfer efficiency due to a too high surface temperature is the Leidenfrost effect, which is well known to those skilled in the art. To reduce the Leidenfrost effect, coatings have been applied on the surface of the steam iron. Those coatings can contribute positively to the efficiency of the heat transfer as they reduce the surface temperature.

Another effect that determines the evaporation rate of water is the wettability of the steam chamber surface. If dosed droplets spread easily on the surface a larger surface area is used for the evaporation, and, therefore, the evaporation time is shorter. This effect is enhanced if the layer applied on the surface is porous. In that case the liquid can penetrate into the layer by capillary forces and a large surface area is used to evaporate the liquid. The capillary effects will only take place rapidly if the porosity is high and the wetting is good. Therefore a hydrophilic porous coating can contribute positively to the efficiency of the heat transfer as it will increase the surface area used.

Yet another factor influencing the evaporation rate is the presence of additives. These additives, for instance fragrances, can be added to the water tank of an iron and will be vaporized in the steam chamber. These additives are frequently surface active, have different boiling points than water and the formulations in which they are available may include co-

solvents. Coatings that enhance the evaporation rate will reduce problems with the steam formation in the presence of these additives.

To achieve efficient steaming, both organic and inorganic coating materials have been applied in steam chambers. The first requirement is that coatings used in steam generating devices should have a high temperature resistance. Therefore, heat resistant organic polymers, such as poly-imides, are often used as a binder in steam chamber coatings. Poly-imide based coatings are efficient as thermally insulating coatings, however, poly-imide is fairly hydrophobic. Consequently, the contact area of a single drop with the steam chamber surface is relatively small, which leads to fairly slow conversion of water into steam.

Completely inorganic coatings have a better temperature stability. They have also been used as steam chamber coatings, see for instance those described in US 5,060,406 and GB 773,741. These coatings have a degree of porosity, which, together with their hydrophilicity, leads to an increase in the surface area, leading to very high steam rates if used at the proper temperature. However, the porosity of the coatings should be limited, as the liquid to be evaporated should not be able to reach the metal surface, which can easily be at a too high temperature for efficient steam formation.

The present invention aims to provide for a coating for a steam generating device, such as a steam chamber in an iron, that does not show the above problems. To that end, the present invention provides for a coating for a steam generating device according to the preamble that is characterized in that it comprises a first layer and a second layer, wherein the first layer is essentially impermeable to water and the second layer is hydrophilic.

According to the invention, first a relatively dense, thermally insulating and essentially water impermeable layer is deposited on a heat conducting substrate and on top of this layer a hydrophilic porous layer is applied. The dense layer will lower the substrate temperature to a value below the Leidenfrost point while the second layer will be porous and hydrophilic and, therefore, ensures an efficient spreading of the liquid. Each of the two layers may comprise sublayers and in addition an adhesion promoter may be applied in-between the first and second layer.

The composition used for the second layer can be different from that of the first layer or it can be the same. If the same composition is used, a variation in porosity of the layer can be obtained through a change in the application technique. If for instance spray-coating is used, a relatively dense layer will be formed if the distance between the spray gun and the substrate to be coated is small. The freshly deposited layer will be wet and a dense film can be formed after drying. If the distance between the spray gun and the substrate is

increased, allowing more evaporation of solvent from the sprayed droplets before they reach the surface, a more porous layer is formed.

Variations in the porosity, leading to an impermeable first layer and a porous second layer, can also be established by choosing compositions of the same starting materials but with different binder to filler ratios. Depending on the filler shape and size distribution a maximum particle volume fraction in the deposited layer can be found, which is, for commercially available polydisperse powders, usually around 40-55%. If the amount of binder is insufficient to fill up the rest of the volume, porous layers will be obtained. If enough binder is present, dense layers can be deposited, provided that suitable deposition techniques are chosen. A similar composition but with a higher particle/binder ratio can be used to obtain the porous top-layer. The particle size co-determines the pore size for the porous layer, for the dense layer the particle size should not exceed the thickness of the layer.

The materials chosen for the dense thermally insulating layer and the porous layer can also be different. This gives the freedom of choosing a hydrophobic materials, preferably materials with good thermally insulating properties such as polyimide as a first layer and a thin layer of a hydrophilic material on top.

Many materials are suitable for the thermally insulating layer, provided that they have sufficient thermal stability and that a sufficient thickness can be reached. Polyimide based binders filled with inorganic particles can be used, just as enamels or phosphate glasses. Particle filled sol-gel materials can also be advantageously used to deposit a first layer on the surface of the steam chamber, especially hybrid sol-gel precursors, which contain less than four hydrolysable groups can be used. Of the hybrid sol-gel precursors, layers made from methyltri(m)ethoxysilane and phenyltri(m)ethoxysilane have the best temperature stability. The thickness of the thermally insulating layer is typically around 30  $\mu\text{m}$ , but thicker layers, up to 80  $\mu\text{m}$  and above have been applied. A preferred method for the application of the layer is spray-coating. Depending on the curing profile and application technique relatively dense layers of polyamide imide and methyltrimethoxy silane will take up around 0.5-3% of water, which is considered as essentially impermeable.

On top of this first dense layer, a hydrophilic porous layer can be applied. These porous layers can be made from materials that are hydrophilic, Examples of materials, which are specifically suitable for the second layer are mono-aluminum phosphate binders filled with inorganic particles, for instance clay particles,  $\text{SiO}_2$  particles or  $\text{Al}_2\text{O}_3$  particles. Alternatively, a sol-gel precursor can be chosen as a binder. Even systems without binder, such as certain types of colloidal silica have been used successfully. A typical thickness of



the porous layer is about 15  $\mu\text{m}$ . As long as the adhesion to the first layer is strong, some degree of cracking will not adversely affect the functionality of the steam chamber coating. A preferred method for the application of the layer is spray-coating.

Although separate curing of the two layers is possible, it is advantageous to cure the two layers together. This saves a curing cycle and, more importantly can improve the adhesion between the two layers.

The invention is further illustrated in the following examples and the accompanying drawing, in which:

Fig. 1 shows the reciprocal evaporation time of 0.5 g droplets of water on a polyamide/imide coating, with and without a top-coat of silica (Ludox) as disclosed in example 1; and

Fig. 2 shows the reciprocal evaporation time of 0.5 g droplets of water on a MTMS base-coat and a silica (ludox) or alumina topcoat as a function of temperature as described in examples 2 and 3.

#### Example 1

A double layer coating was prepared using a polyamide/imide resin containing mica and aluminum flakes. The total volume fraction of fillers in the layer is 48%. The layers were applied by spraycoating on an aluminum substrate. The coating was cured at 280°C for 10 minutes after which a second layer was spraycoated consisting of a commercially available silica sol, Ludox AM, which was diluted to 3% with deionized water. No subsequent heat treatment was performed. The thickness of the polyamide/imide layer is about 40  $\mu\text{m}$  and the thickness of the Ludox layer is about 10  $\mu\text{m}$ . The reciprocal evaporation time of a 0.5g water droplet as a function of the substrate temperature is given in Figure 1. For comparison the reciprocal evaporation time of a droplet on a single layer coating of the polyamide/imide coating is given in the same Figure. The evaporation rate of the dual layer system is significantly higher over the entire temperature range.

#### Example 2

100 g of methyltrimethoxy silane (MTMS) in 50 g of ethanol was hydrolyzed by addition of 1.4 g of maleic acid and 77 g of de-ionized water. After hydrolysis, 23 g of Al flakes and 47 g of mica flakes were added. This lacquer was spray coated onto an aluminum

substrate to form a dense first coating layer. The layer was dried at about 100°C after which an aqueous silica sol was dosed onto the coating. After drying of the silica layer, the layers were co-cured at 300°C. The resulting thickness of the first MTMS coating was 100  $\mu\text{m}$  and the thickness of the silica layer was 25  $\mu\text{m}$ . Figure 2 shows the evaporation rate of 0.5g water droplets. Without the application of the second layer the evaporation rate is too low to be measured.

### Example 3

10                    100 g of methyltrimethoxy silane (MTMS) in 50 g of ethanol was hydrolyzed by addition of 1.4 g of maleic acid and 77 g of de-ionized water. After hydrolysis, 23 g of Al flakes and 47 g of mica flakes were added. This lacquer was spray coated onto an aluminum substrate by spray-coating. The layer was dried at about 100°C after which a 1 M alumina-sol, prepared from hydrolysed aluminum sec-butoxide and filled with alumina particles, was  
15 spray-coated on top of this layer. The layers were cured at 300°C. The thickness of the first dense layer was 54  $\mu\text{m}$  and the thickness of the topcoat layer was 14  $\mu\text{m}$ . The evaporation rate of 0.5 g water droplets was the same as that observed in example 2, see Figure 2. Without the application of the second layer the evaporation rate is too low too be measured.

## CLAIMS:

1. Coating for a steam generating device comprising a first layer and a second layer, wherein the first layer is essentially impermeable to water and the second layer is hydrophilic.
- 5 2. Coating according to claim 1, characterised in that the second layer is a porous layer.
3. Coating according to claim 1, characterized in that the first layer comprises poly-imide, polyamide-imide, enamel, phosphate glass, a sol-gel derived material or a  
10 combination thereof.
4. Coating according to claim 3, characterized in the layer also contains inorganic particles.
- 15 5. Coating according to claim 1, characterized in that the second layer comprises a phosphate glass or a sol-gel derived material
6. Coating according to claim 1, characterized in that the second layer comprises inorganic particles  
20
7. Coating according to claim 1, characterized in that the second layer comprises silica particles.
8. Coating according to claim 1, characterized in that the second layer comprises  
25 particles with an average diameter smaller than 1  $\mu\text{m}$ .
9. Coating according to claim 1 characterized in that the layer thickness of the first layer is in between 10 and 100  $\mu\text{m}$  and the second layer is in between 1 and 15  $\mu\text{m}$

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10. Coating according to claim 9, characterized in that the steam generating device is part of an electrical domestic appliance such as a steam iron, a system iron, a steamer, a garment cleaner, a heated ironing board or a facial steamer.

**ABSTRACT:**

A two layer coating for application in a steam generating device is disclosed. A impermeable first layer thermally insulates the heated surface, while a second porous layer enlarges the contact area, leading to efficient conversion of liquid into vapor.

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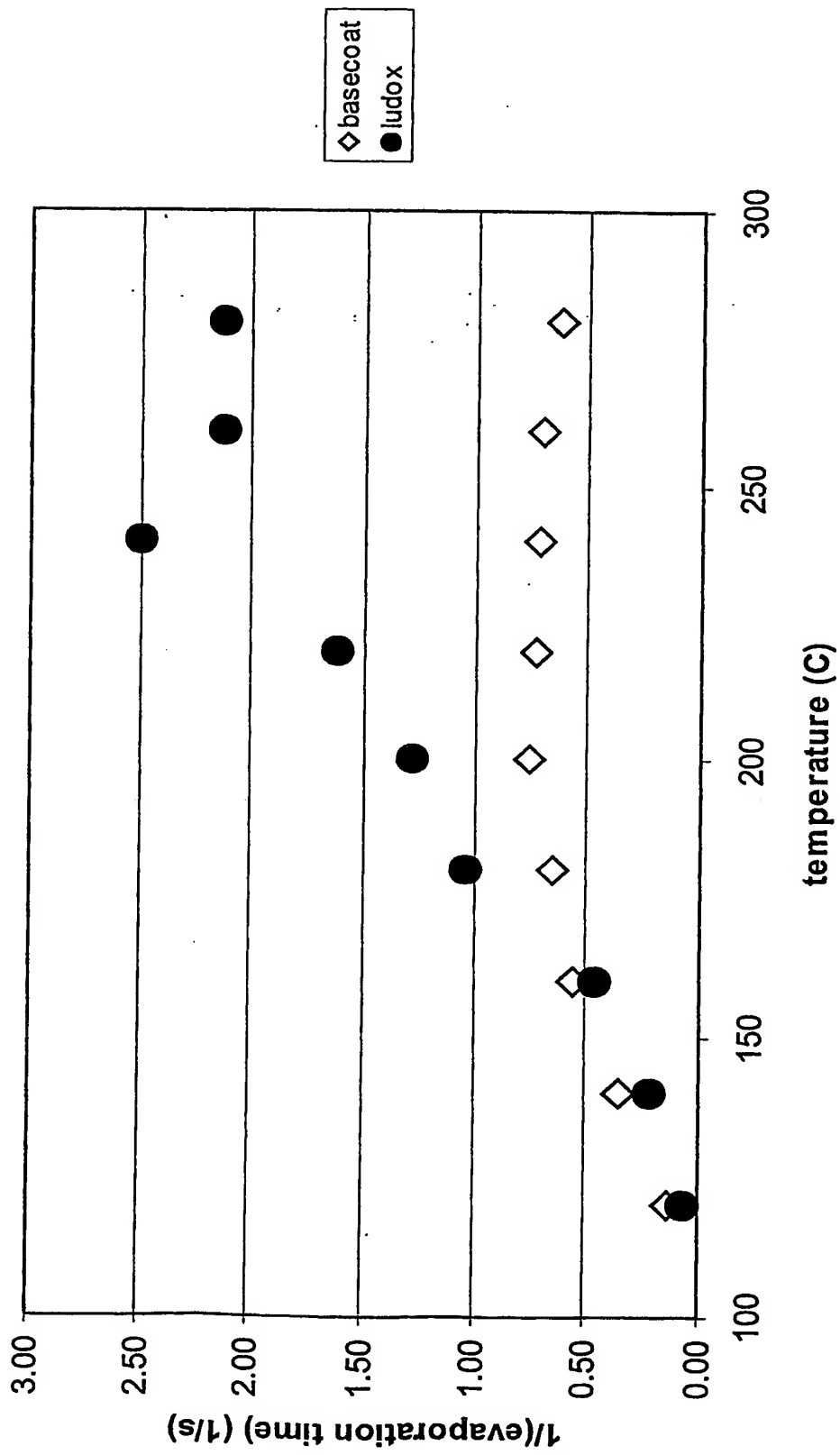


FIG.1

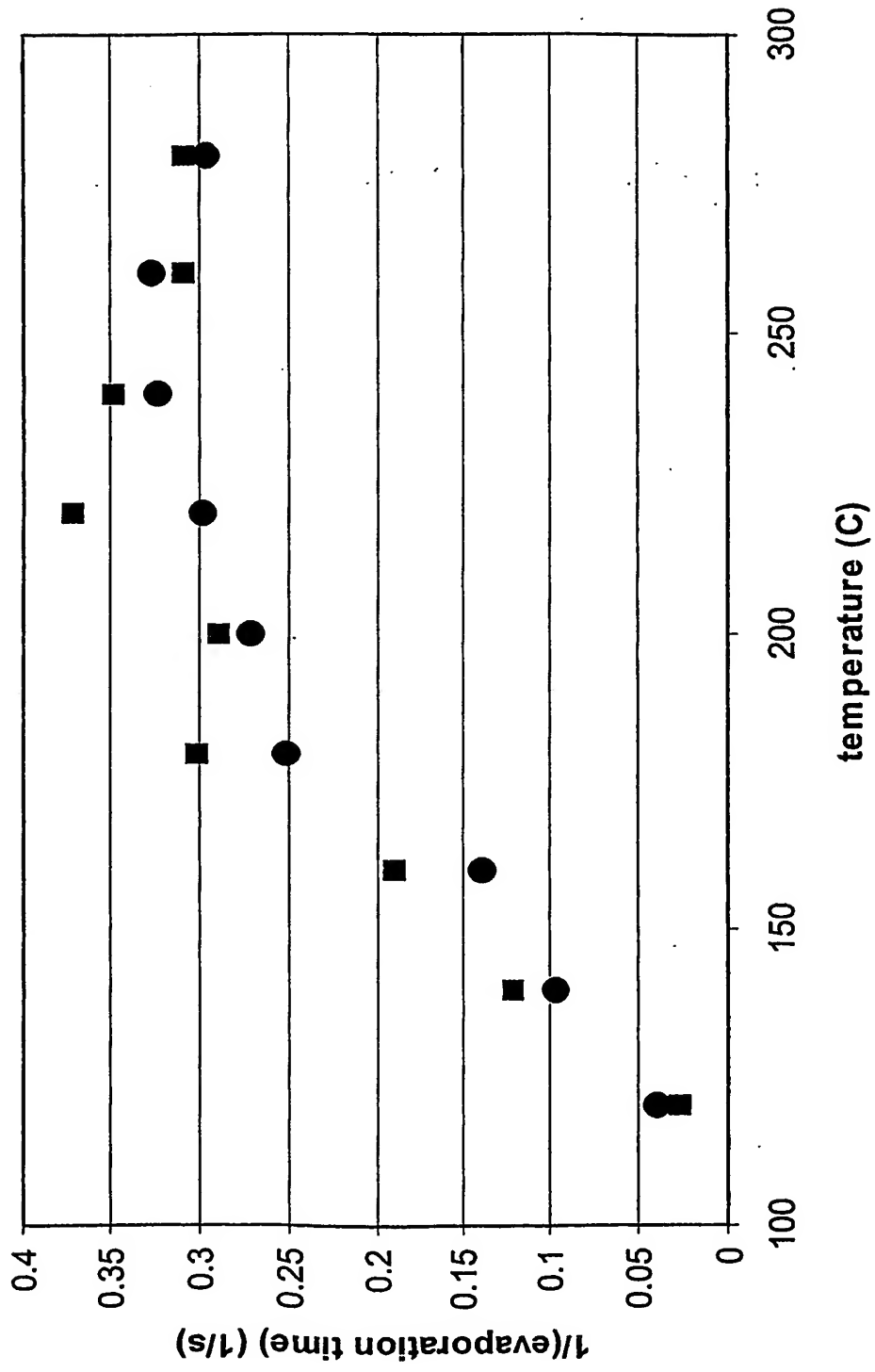


FIG.2

## INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER  
 IPC 7 B32B15/08 D06F75/18

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B32B D06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, COMPENDEX

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 462 842 A (TAKENAKA HIROICHI ET AL) 31 July 1984 (1984-07-31) column 2, line 7 - column 3, line 4; examples	1,2,5,7
A	DE 198 55 151 A (ZEH JENS) 31 May 2000 (2000-05-31) the whole document	1-10
A	US 5 390 432 A (BOULUD HENRY ET AL) 21 February 1995 (1995-02-21) column 2, line 37 - column 3, line 59; figures	1-10
A	US 3 551 183 A (VONDRACEK CHARLES H ET AL) 29 December 1970 (1970-12-29) column 2, line 57 - column 3, line 64 column 3, lines 45-64	1-10

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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